

# PATENT ABSTRACTS OF JAPAN

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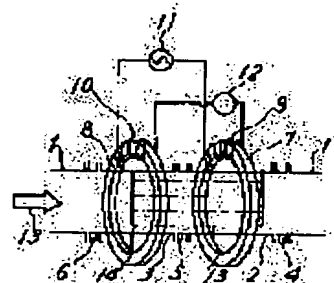
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## (54) DISCHARGE PLASMA GENERATOR

### (57)Abstract:

**PURPOSE:** To provide a discharge plasma generator which can change discharge performance corresponding to a purpose by using an induction electric field where a comparatively high voltage is easily available without using a microwave, and by changing the forms of discharge electrodes or intervals thereof or the frequency of an applied voltage.

**CONSTITUTION:** Two or more ring-like magnetic substances 7, 8 are arranged at the peripheral portions of pipings 2, 3, and coils 9, 10 are wound around the ring-like magnetic substances 7, 8, and also electrodes 13, 14 to promote discharge are arranged inside the pipings 2, 3. Atmospheric pressure or exhaust gas or specific gas whose pressure is lower than the atmospheric pressure is made to exist inside the pipings so that discharge plasma is generated inside the pipings 2, 3 by applying AC voltage to the coils 7, 10.



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**CLAIMS**

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[Claim(s)]

[Claim 1] The discharge plasma generator which arranges the electrode which promotes discharge inside this piping, and is characterized by making the exhaust gas or the specific gas of the low voltage in said piping exist, impressing alternating voltage to said coil, and generating the discharge plasma in said piping from atmospheric pressure or it while arranging the two or more ring-like magnetic substance in the periphery section of piping and winding a coil around this ring-like magnetic substance.

[Claim 2] The discharge plasma generator characterized by controlling discharge-starting plasma generating by making into a suitable value the frequency of the alternating voltage energized in said coil.

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**DETAILED DESCRIPTION**

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[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the discharge plasma generator using induction electric field.

[0002]

[Description of the Prior Art] Drawing 4 is drawing showing the outline configuration of the conventional discharge plasma generator. In drawing, 43 is discharge piping and is the structure which the coil 42 wound around the periphery of this discharge piping 43. While passing exhaust gas in the discharge piping 43, the discharge plasma is generated in the discharge piping 43 by energizing a microwave current from the microwave power source 41 to said high frequency coil.

[0003]

[Problem(s) to be Solved by the Invention] Conventionally [ above-mentioned ], although microwave is used in the discharge plasma generator of a configuration, in order to be discharge starting, when the pressure of gas [ gas ] (drawing exhaust gas 44) to make it discharging was not low to some extent, there was a fault of plasma-being hard toize.

[0004] This invention was not made in view of the above-mentioned point, and the configuration and spacing \*\*\*\*\* of a discharge electrode aim at offering a discharge plasma generator changeable [ / for the purpose of the discharge engine performance ] by changing the frequency of applied voltage, using the induction electric field which the high voltage tends [ comparatively ] to obtain, without using microwave.

[0005]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, this invention arranges the electrode which promotes discharge inside this piping, and is characterize by make the exhaust gas or the specific gas of the low voltage in piping exist, impress alternating voltage to a coil, and generate the discharge plasma in piping from atmospheric pressure or it while arrange the two or more ring-like magnetic substance in the periphery section and wind a coil around this ring-like magnetic substance.

[0006] Moreover, it is characterized by controlling discharge-starting plasma generating by making into a suitable value the frequency of the alternating voltage energized in a coil.

[0007]

[Function] By constituting discharge plasma equipment as mentioned above, if pulse-like alternating voltage is impressed to the coil wound around the ring-like magnetic substance, it will be magnetized and this magnetic substance will be generated in the direction in which the induction electric field proportional to the time amount differential coefficient of this pulse shape impressed negate said magnetization inside piping. If pulse shape is the ingredient in which it starts and the magnetic substance has the sharp property to follow it, with falling at this time, it is possible to make inter-electrode [ which was attached in piping ] produce the big potential difference. The configuration and spacing of this electrode are changed, or by changing the frequency of alternating voltage, it is possible to change the discharge engine performance, and even place [ of gas pressure / high ], discharge becomes easy.

[0008]

[Example] The example of this invention is explained based on a drawing below. Drawing 3 is drawing for explaining the principle of the induction electric-field generator of this invention. In drawing, 34 is discharge piping with a discharge electrode, and the magnetic substance 32 of the shape of a ring which consists of a ferrite etc. is arranged at the periphery of this discharge piping 34. If the coil 33 is wound around the magnetic substance 32 of the shape of this ring and pulse-like alternating voltage is impressed to this coil 33 from RF generator 31, the magnetic substance 32 will be magnetized.

[0009] By magnetizing the magnetic substance 32, the induction electric field proportional to the time amount differential coefficient of the pulse shape impressed are generated in the direction which negates magnetization inside the discharge piping 34. If pulse shape is the ingredient in which it starts and the magnetic substance 32 has the sharp property to follow it, with falling at this time, it is possible to make inter-electrode [ which was attached in the discharge piping 34 ] produce the big potential difference. The configuration and inter-electrode spacing of the discharge piping 34 are changed, or it becomes possible from alternating current RF generator 31 to change the discharge engine performance by changing a pulse frequency. Therefore, discharge becomes easy even place [ of gas pressure / high ].

[0010] Drawing 1 is drawing showing the outline structure of a discharge plasma generator where the induction electric field of this invention were used. In drawing 1, 1 and 1 are piping which lets exhaust gas pass, and two discharge piping 2 and 3 is inserted through the piping 4, 5, and 6 for an insulation between this piping 1 and piping 1. The magnetic substance 7 and 8 of the shape of a ring which becomes the periphery section of each of the discharge piping 2 and 3 from a ferrite etc. is arranged, and coils 8 and 9 are wound around each of these magnetic substance 7 and 8. A coil 8 and a coil 9 are connected to a serial, and {the (a) of drawing 2 R> 2 referring-to} impression of the pulse-like electrical potential difference is carried out from RF generator 11. 12 in drawing is a phase shifter which changes the phase of the electrical potential difference impressed to a coil 9. Moreover, discharge electrodes 13 and 14 are arranged inside the discharge piping 2 and 3.

[0011] Actuation of the from plasma nature equipment of the above-mentioned configuration is explained using the wave form chart of drawing 2. If the electrical potential difference of a square wave as shown in (a) of drawing 2 from RF generator 11 is impressed, it would be proportional to the time amount differential coefficient of applied voltage as shown in the interior of the magnetic substance 7 at (b) of drawing 2, namely, the internal field E1 which forms a large peak in the starting falling section of an impression pulse voltage will occur. Moreover, when there is no phase shifter 12, inside the magnetic substance 8, the internal field E2 as shown in (c) of drawing 2 occurs. If there is no phase shifter 12 to the extent that it seems that it is indicated in (c) as (b) of drawing 2, a gap of the peak of an internal field E1 and an internal field E2 will occur, and it will become inconvenient. Then, the phase of the electrical potential difference impressed to a coil 9 by the phase shifter 12 is shifted, and as shown in (d) of drawing 2 R> 2, it is made in agreement [ the peak of an internal field E1 and an internal field E2 ].

[0012] Discharge electrodes 13 and 14 are arranged inside the discharge piping 2 and 3, the big potential difference arises in inter-electrode [ of this discharge electrode ], and the discharge plasma occurs. By constituting a plasma generator like drawing 1, the insulating piping 4, 5, and 6 and the magnetic substance 7 and 8 have been independent of the discharge piping 2 and 3 electrically, and discharge actuation has the merit of generating only inside the interior of the discharge piping 2 and 3.

[0013] Through piping 1 and 1, by passing exhaust gas in the discharge piping 2 and 3, the discharge plasma occurs in exhaust gas and, thereby, N<sub>2</sub>, O<sub>2</sub>, and HO<sub>2</sub> in exhaust gas become active species OH, O, and HO<sub>2</sub> in the plasma generator of a configuration of being shown in drawing 1. This generated active species reacts with SO<sub>2</sub> in exhaust gas, and serves as a sulfuric acid. That is, NH<sub>3</sub> and the reaction salt (by-product) by which the sulfuric acid generated SO<sub>2</sub>+2 OH->H<sub>2</sub>SO<sub>4</sub> SO<sub>2</sub>+O->SO<sub>3</sub>+H<sub>2</sub> O->H<sub>2</sub>SO<sub>4</sub>, thus the bottom was added are built, and exhaust gas is processed. Namely, H<sub>2</sub>SO<sub>4</sub>+H<sub>2</sub> O+NH<sub>3</sub> ->(NH<sub>4</sub>) 2SO<sub>4</sub> (ammonium sulfate)

It becomes.

[0014] Moreover, the components CO, HC, N<sub>2</sub>, and O<sub>2</sub> in exhaust gas and H<sub>2</sub>O turn into OH, O, HO<sub>2</sub>, N<sub>2</sub>, H, HC, and CO. These active species N<sub>2</sub>, HC, and CO react with NO in exhaust gas, and serve as NO+2H ->1/2N<sub>2</sub>+H<sub>2</sub>ONO+2 H+HC->1/2N<sub>2</sub>+CO<sub>2</sub>+H<sub>2</sub>ONO+2 H+CO->1/2N<sub>2</sub>+CO<sub>2</sub>.

[0015] A plasma generator can be used as mentioned above also as offgas treatment equipment which processes SOX in exhaust gas, and NOX.

[0016]

[Effect of the Invention] Since the discharge engine performance is changeable by changing the electrical-potential-difference electrical-potential-difference frequency impressed to the conditions or coils of an electrode inside piping, such as configuration spacing, according to this invention as explained above, it is possible to generate strong electric field, gas pressure is not chosen, and the outstanding effectiveness that the discharge plasma can be generated is acquired.

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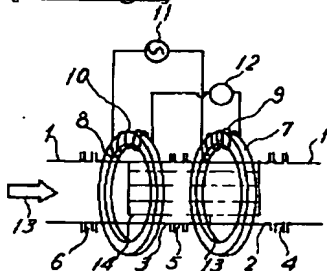
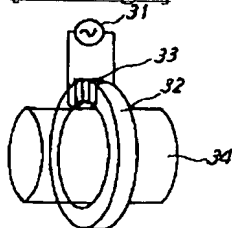
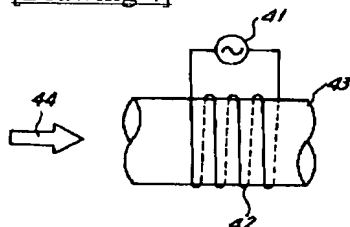
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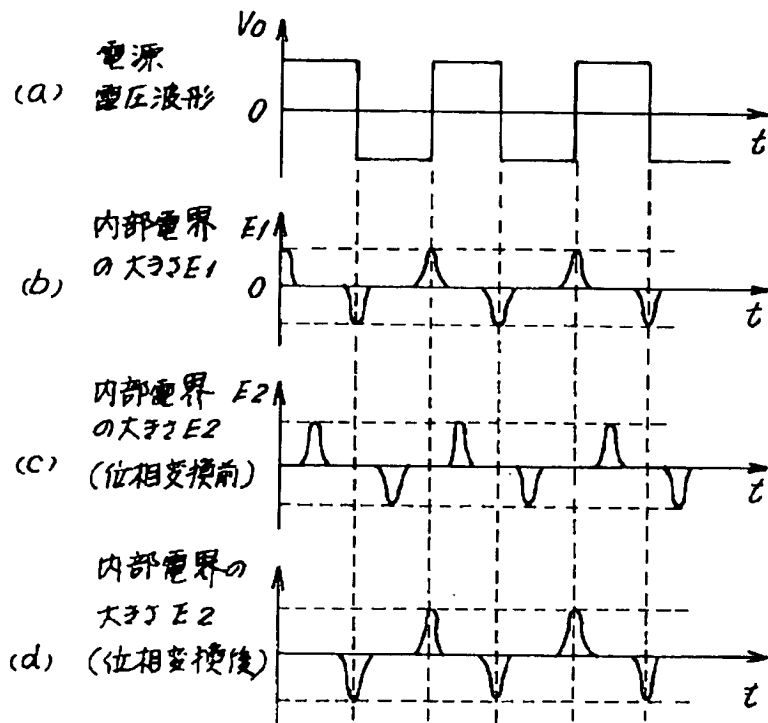
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**DRAWINGS**

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[Drawing 1][Drawing 3][Drawing 4][Drawing 2]



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